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EDITORIAL

DISEASE IN RELATION TO ANIMAL HUSBANDRY

DURING the last two decades attention has been drawn increasingly to the subject of animal husbandry, and now it is recognised that the well-being of all life, plant or animal, including the human, depends fundamentally upon a close and harmonious inter-relationship. To the small band of specialists and enthusiasts this has been obvious for many generations, but to the great majority or those whose minds were obsessed by physical form or by factors associated with disease these lessons were not so apparent. It is strange that the great increase in pathological and especially bacteriological knowledge which has evolved during the last eighty or so years has, if anything, somewhat retarded advances in the major subject, i.e., animal husbandry. The general trend of thought has been apt to become too much disease conscious, seeking explanation through the microscope or test-tube rather than in the field amongst the living animals. There is no doubt that disease is a great factor in any system of animal husbandry, but it is only one, and there are other things, such as nutrition, genetics and environment, which are of at least equal moment. Nowadays knowledge on such matters is not confined to the selected few; much of the scientific background is already widely known, and agriculturalists and consumers are calling for action. At one time it was thought that all that was necessary was a knowledge of the causal organisms of a disease and of its habits, and then, by means of legislation, control, even elimination, could be effected and all would be well. Time has proved this to be fallacious, for not only in this country, but in many parts of the world, especially on the continent of Europe, where they

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are more control-minded than in any other part of the world, disease, even those which have been most subjected to attack, flourishes and good health wilts.

Slaughter-houses appear to report almost as great an incidence of disease as ever. Legislation has had one good effect in that it has protected the consumer, but it has failed in great measure to help the producer and to give him that assistance which would enable him to improve his product and at the same time be free from economic hazards incident upon disease.

Tuberculosis is not only a great killer, but it is probably the greatest retarder of good health with which the animal world is inflicted. It may be said with truth that animal husbandry as applied to cattle can never approach an ideal state, until the ravages of this disease are either controlled or, better still, eliminated.

Mr. Pool has done well to draw attention to this, and we commend his address to all our readers. Tuberculosis is one of the major diseases, and it has been the subject of investigation over a long period of time. A great volume of knowledge is already at hand. It may be that if we can pursue the fight against this dread disease to a successful conclusion the lessons learnt may be applied to other diseases, and so help greatly towards the goal, freedom or protection from disease, which is the *sine qua non* of good animal husbandry.

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[Photo by Elliott & Fry

An Appreciation

FRED BULLOCK, LL.D.

Secretary and Registrar, R.C.V.S., 1907-1946

FRED BULLOCK died peacefully at his home in Bloomsbury on Thursday, February 14. We mourn the passing of a man who over a period of almost forty years dedicated his life to the Veterinary profession.

He was the son of Thomas Henry and Hester Bullock, and was born at Stafford on February 15, 1878. He was not born with a silver spoon in his mouth, as times were hard for the family when he was a child. He went to the local elementary school, and it looked as if this was all the education that might come his way, but when he was twelve years old a scholarship was offered for a period of two years at Stafford Grammar School. It was a competitive one. He entered, prepared himself for the examination, and won the award. He remained at the Grammar School for the period named and, having acquitted himself well, he was then appointed to a position as office boy in the Technical Department of the County Council. In this post he came under the notice of Mr. Jones, the Director, and Professor Turner, of Birmingham University. These men recognised the worth of the boy and gave him every encouragement for, in the words of Professor Turner, "they considered him to be a boy of no mean ability." Whilst in the Technical Department he seized every opportunity to advance his knowledge, and it was not long before he was of such proficiency in shorthand that he was appointed a teacher in the evening school. At the same time he became quite an expert with the typewriter and studied the French language. He was soon able to converse in that language with ease and was reputed to be the best French scholar in the town. He obtained the Diploma Superieur de Langue Français of the University of Caen. He did not confine his studies to the French language alone, for he acquired also a sound knowledge of German and Latin and a working knowledge of several other European tongues. Such a boy was bound to attract attention. He came under the notice of the county education authorities, and after undergoing a severe test he was appointed to conduct French conversational classes at the evening school. He was the founder of the Cercle de Français de Stafford and a member of the Modern Language Association. Promotion followed. He held the post of County Council Inspector of Commercial Evening Schools, 1900-07, and eventually became chief assistant to the Director of the Higher Education Department. The Director at this time was Sir Graham Balfour, a cousin of R. L. Stevenson. Sir Graham held Bullock in high regard and was largely responsible for his promotion.

It was whilst occupying this post that he applied for and received the appointment as Secretary to the R.C.V.S. He took up these duties on February 1, 1907. That he was held in high regard by his employers and fellow townsmen is evident when one reads the account of a farewell dinner and presentation on the occasion of his leaving Stafford to take up his new appointment in London.

Mr. Wheeldon, his old schoolmaster, speaking with evident pride in his pupil, said: "It had been a hard struggle for Mr. Bullock but, acting up to his principles and his sterling character, he had faced his great difficulties with a

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manly courage. He was the finest example of grit and preseverence that he (the speaker) had ever met with."

No truer words were ever uttered, for Fred Bullock had succeeded in the face of difficulties which would have swamped any ordinary man.

The family was poor and his father was in poor health, and so whilst still almost a boy he had to become the breadwinner. He had three sisters and three brothers. Young Bullock shouldered his task manfully, for nothing came easy. On the one hand there was his active brain grasping and searching for intellectual food wherever it might be found; on the other hand there was the constant call of the family and its day-to-day needs. At first the burden fell upon the mother and Fred. Theirs was a life of constant planning and scheming and hard work to provide for the others. Then came tragedy. His mother, to whom he was devoted, died when he was only 19 years of age. He was left to carry on the battle alone. As all who knew him would expect, he responded with increasing energy to the greater call, and assumed the duties and responsibilities of head of the family. This was no mean task, for the eldest child, a sister, was 17 and the youngest a boy one year old. He provided for them all and it was not until he had reached the age of 35 that he could say that his task was completed. To his great sorrow the youngest child died in 1922. He worked day and night to find the money for his great task, for he was not content to provide just food and clothing: they must also be educated to the best standard possible and successfully launched on a career. These efforts made great calls on mind and body; he literally burnt the candle at both ends and he was at pains to keep as fit as possible. He took a great interest in athletic sports, but his perforce had to be one which did not involve the outlay of much money. He was a good runner and a fair gymnast, and even as late as 1937 he was seen demonstrating cartwheels on the sands to his son, and when returning home for the last time from the office he took a run round Bloomsbury Square just to loosen up, for his muscles were stiff after a tiring period at the desk. Somehow during these laborious years he found time to advance his knowledge and culture, to work for his church and to undertake social service by acting as secretary to the Stafford Institute. There is no doubt that the struggles of these years only served to stimulate and accentuate the moulding of the fine character of the courteous gentleman that some of us were privileged to know in later times.

This brings us to the year 1907, when at the age of 29 he was appointed to succeed Arthur William Hill as Secretary and Registrar to the Royal College of Veterinary Surgeons. He left his native town with some regret, for he had made many friends, every moment had been occupied in useful tasks and he was beginning to reap the reward for all his efforts.

Bullock's reply when he was called before the Council of the R.C.V.S. and informed that he had been selected for the post was typical of the man. "I shall always do my best so to serve you that you will never regret the choice you have made to-day."

How true these words are to-day. We of the profession in 1946 can look back with some pride to those astute and far-seeing men who formed the Council in 1907 that they, men elected by the free vote of their fellows, should have selected this man of all the many applicants for the post.

And so began forty years of service to the profession, so untiring and so

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devoted that one realises that the words he uttered were those of dedication to a great task.

When he took up his duties Sir John Macfadyean was President of the College, and he took the young man under his wing. Bullock was wont to speak with feeling of how much he owed to that great man. Sir John was his pilot through those early years. Bullock took lodgings in Camden Town and on his way to the office he would call at the R.V.C. for advice and guidance. Sir John was always kind and helpful and did much to smooth the path of a young man on strange and intricate ground. It is not to be wondered that with such a guide and mentor, coupled with his own inherent ability, Fred Bullock was soon master of his new job. In those early years he found time to continue his social welfare activities. He joined the Brotherhood Church at Hoxton and in association with the Rev. Mr. Swan and George Lansbury did much for the people in the East End. This was a side of his life that was not generally known to his veterinary friends. It was an interest which continued throughout his life, being limited only by health and the ever-increasing pressure of his official duties.

His new life at the R.C.V.S. soon became a vocation and he became more and more "steeped in the profession." He attracted the attention of Sir Fred Smith, who at that time was gathering material for his History of Veterinary Literature. Smith found in Bullock the complete amanuensis who by virtue of his knowledge of foreign languages opened many doors that previously had been closed to the master and so enabled the latter to widen the scope of his literary and historical research far beyond his original hopes. Bullock was himself a historian and littèrateur of no mean renown and possessed of a profound knowledge of French literature.

In 1913 he published "La Fondacion de la Colonie Français de la Côte d'Ivorie." In this he proved that it was Marcel Treich Laplene and not, as had been generally accepted, Captain Binger who secured the colony for France. In his literary and historical work he was assisted later by his wife. Together they were largely responsible for the improvement and extension of the old R.C.V.S. library until under its new title, "The Central Library for Animal Diseases," it ranks as one of the foremost of its kind in the world. He became so immersed in his work that not only were the normal office hours occupied but also most of those which normally one consigns to recreation or sleep. However, a busy man can always find time for something else, and so, desirous of gaining a knowledge of law, he entered Grays Inn as a student. He passed the examinations of the Council of Legal Education with first-class honours, was eighth in order of merit in Part II examination, and was called to the Bar at Grays Inn in 1926. In 1924 he took the intermediate LL.B. of London University with honours and the final LL.B. with honours in 1926. In 1928 he proceeded to the Doctorate in Law, LL.D. His thesis was entitled "The Law Relating to Medical, Dental and Veterinary Practice." This thesis ranks as a standard work to-day. It will be seen that in London Bullock continued in the manner in which he had started in Stafford. He seized every opportunity to enhance his knowledge and culture, and incidentally to render more and more valuable service to his employers.

Honours came his way. France showed her appreciation, appointing him

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Officier de l'Ordre du Nichau Iftikhan de Tunis (1929) and Chevalier de Legion d'Honneur (1934). The Central Veterinary Society of London elected him Honorary Fellow in 1929, and in 1944, on the occasion of the centenary of the R.C.V.S., awarded him its highest honour, i.e., the Victory Medal. He was a member of the Worshipful Company of Farriers, a member of the court of that company, and a Freeman of the City of London. In 1927 the President and Council of the R.C.V.S. presented Dr. and Mrs. Bullock with a silver tea and coffee set to mark their deep appreciation of twenty years of devoted service to the council and profession.

For over thirty years he acted as secretary to the Victoria Veterinary Benevolent Fund. This was a job dear to his heart and in which he never spared himself. He had the satisfaction of seeing the fund grow from a very modest one to the strong concern it is to-day. It may be said with truth that this metamorphosis is in no small measure due to Fred Bullock.

He was a great reader whose tastes ranged over a wide field; he wrote with a scholarly pen and had the gift of lucid speech. He frequently addressed the meetings of Veterinary Societies and could always command a full, attentive and appreciative audience. His writings remain as a permanent treasure in our archives. Amongst these are: "Handbook for Veterinary Surgeons, 1927," "Notes on the Early History of the Veterinary Surgeon in England," "The Mulo medicina Chironis" and Volume IV of "The History of Veterinary Literature."

In 1930 he functioned as General Secretary of the International Veterinary Congress then held in London. Here he excelled, for his efficiency, courtesy and gift of tongues made him *persona grata* with everyone and the very "king-pin" of the congress.

He began his studies in law rather late in life, but he entered upon them with a devotion and enthusiasm which, we are told by his friend and contemporary, Mr. H. Edmund Davis, K.C., put far younger students to shame. It was not long before his fellow students were leaning on him and looked to him for help and guidance. Although he did not practise in the courts he kept in active contact with Grays Inn. One of his relaxations was to attend there for lunch. He had a favourite seat, and the table he favoured was known as "Bullock's" and was the rendezvous of those in search of intellectual and debating treat. In 1940-41 he was Worshipful Master of Grays Inn Lodge of Freemasons, and at the time of his death held office as Secretary.

When he began his service at the R.C.V.S. there were ominous signs that the profession had seen its best days. It was in the early days of mechanical transport, and though the shadow was then no bigger than a man's hand there were those who foretold the doom of the profession. This had its effect upon the number of students entering upon the course of study and incidentally upon the finances of the college. The main source of income, i.e., students' fees, was drying up, and the time came when the college began to live on its capital. These were trying times, and it was not until 1920 or so, when the annual fee was instituted, that the finances of the college became assured for the future. Bullock's work did not decrease; rather it increased in these bad times, and he had to work at high pressure with a staff completely inadequate in numbers. The 1930's saw a great change for the better, and for a few years he was free

from these anxieties. Then came 1939 and war. In late 1940 the office was evacuated to Harrogate, and the work had to be carried on under great personal and office inconveniences. He was again faced with an acute shortage of staff and an ever-increasing volume of work. They took their toll on the man, yet when the time came to return to London he appeared to recover.

There is no doubt also that the threats of changes in the constitution and duties of the R.C.V.S. and the unjustified attacks made on the college and profession affected him profoundly and undermined his health.

In July, 1945, he was near breaking point and was given leave of absence in the hope that he might so recover his health and spirit. He resumed work in November, 1945, but early in February, 1946, he had to enter a nursing home. He came home on February 12 at his own request. He was worn and frail and tired, yet there were still hopes that he might recover. He talked with his wife of his plans for the future—a future which had no other object than the welfare of the college. The college, the library and the profession were uppermost in his thoughts to the end. Early on the fourteenth day it was recognised that a change had come over him during the night, and a few hours afterwards his great spirit passed peacefully away.

These bare lines are indeed a poor record of the life and work of this great servant of our profession, yet of the man himself I would now speak.

It was my privilege to know him for over thirty years, first when I was just a boy and later on more intimate terms after qualifying and particularly after joining the staff of the R.V.C. in 1926. First impressions are generally good, and I remember with gratitude his care and kindness to a bunch of nervous students whilst we were awaiting the call to the terrors of our first *viva voce* examination at 10, Red Lion Square. No father could have shown greater care or been more helpful.

He was a smallish, spare man, bubbling over with energy and an unmatched regard and enthusiasm for the profession. He did not waste words, yet every word breathed kindness, and in his keen face and eyes there was a light which burned bright and urged one onward. He was steeped in the past and knew more about the great men of the profession and their deeds than anyone I have known.

He seemed never to forget a face, and I think that he knew every graduate almost personally. One could walk into his office at any time and be welcomed and made to feel that you and your mission were all that mattered for the time being. He was most jealous of the good name of our profession, was ever anxious to raise its status, and would fight like a tiger with anyone who would soil its fame. On occasions when I got him to talk to students his words bore the mark of a modern Hippocrates. He was extremely well informed on many things, and I well remember almost the last time I called to see him it was to ask him if Cromwell's head was really buried in Red Lion Square. I had come across this information in the course of my reading and went fully primed. I soon realised that Dr. Bullock knew more about the occasion than did my author.

He could always see the best side of a man, and I never heard him say an unkind word. Although spare, he was a bundle of energy, and took pains to keep himself physically fit. In his youth he sought relaxation in running;

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later, especially in his early days in London, he would spend his holidays cycling or tramping over the countryside. He loved the garden and enjoyed the physical exercise of digging which, as one would expect of him, he did "scientifically" and with due precision. His pen was never idle, and even on his journeys to and from the office he would jot down short stories and light verse. Some of these I have read, and they reveal a command of language and a subtle whimsical touch which, had he wished, would have placed him in the first rank of authors.

His home life was a happy one. In 1918 he married Janet Lindsay Salmon. She was for him the ideal mate, for they had common interests, especially in the literary line. They worked as a team, and much of the success which crowned his efforts was the direct result of her help and encouragement. She took almost as great an interest in his Royal College work as he did himself, and the library owes much to her. They were blessed with one son who worthily repaid all their efforts on his behalf.

Fred Bullock came to the Royal College at a critical time; he lived to see his work and name honoured amongst men. His life and character can be best assessed by his own modest words on receiving the Victory Medal of the Central Veterinary Society in 1944:

"He had never sought honours for himself; he had always regarded himself as being the servant of the profession in whose guardianship was the honour and dignity of the R.C.V.S. If it be a sin to covet honour for the profession whose servant I am, I am the most offending soul alive."

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General Articles

THE ERADICATION OF TUBERCULOSIS IN CATTLE*

By W. A. POOL, *Weybridge.*

Disease in Relation to Animal Husbandry

THE incidence of disease has had a very great influence upon the manner in which animal husbandry has developed. It has progressed by a perpetual and largely unrealised system of trial and error in past centuries, adjustments being made as disease appeared; the changes which proved successful were those which permitted the owners to make a living and they became the established practice in the maintenance of the animals.

A gradual development took place from primitive herding in conditions where stocking was inevitably light. With the arrival of more and more settled conditions in civilised countries, as man learnt to live in a greater degree of peace with his neighbours, new livestock problems developed. When it became possible to breed intensively and to increase the numbers of livestock, disease problems quite beyond the experience of the primitive agriculturist had to be countered.

In the earlier days the natural resources of stockowners for the control of disease were very limited; adaptations based on rough and ready observations succeeded only where certain types of disease were concerned. The present state of livestock husbandry could not have been reached without the aid given by disease control methods based on scientific knowledge.

* Presidential Address at the Section of Comparative Medicine, Royal Society of Medicine, on October 10, 1945.

During the last century there have been enormous developments in the characters of livestock. With improved capacity to grow and store foodstuffs, together with changes in the nature of the fodder grown, there has been a revolution in animal husbandry. Improved breeds with characters particularly valuable to the community have been evolved. Stocking has become heavier, animals which mature much more quickly than their ancestors have developed and their production has reached standards which are out of all proportion to what might be regarded as natural for living creatures. Animals have become machines with a standard of efficiency that even engineers might envy. In selecting animals for breeding the aim has been to produce particular characters, for example, special capacity for production, such as milk yield or carcase type; at the same time stamina and disease resistance have been neglected. Consequently, the environment and systems of husbandry have tended to produce a high disease hazard, which the animal has a limited capacity to withstand unless it is given extensive protection of such measures as are available from veterinary science.

During the last century it has been necessary to deal with cattle plague and bovine contagious pleuropneumonia. They were so serious that very drastic action was considered worth its extreme cost, and by ruthless slaughter, together with other appropriate measures, these diseases were eradicated. The same is the case with foot and mouth disease. Courage has never been lacking when dealing with it, even when at times the policy of slaughter has been publicly challenged.

Infective disease of the chronic insidious endemic type, such as tuberculosis, has proved to be much more difficult to control than the acute plagues, even after its nature was understood.

With the development of the close herding and housing of cattle, tuberculosis became a very serious disease. The causal organism operates according to the plan of the well-adapted parasite which does not eliminate its host of the future and so jeopardise its chances of survival.

Sir Samuel Garth, a physician and poet of the fifteenth century, said :—

> " While meagre phthisis deals the silent blow,
> Her stroaks are sure, but her advances slow;
> No loud alarms nor fierce assaults are shown,
> She starves the fortress first, then takes the town."

The wastage from disease in this country is a source of great anxiety to all concerned, and this has been evinced publicly by many representative bodies with a knowledge of the position—by the farmers themselves, the National Veterinary Medical Association, government departments and, in a recent memorable debate, the House of Lords.

Certain Important Aspects of the Bovine Tuberculosis Problem

The Extent of Tuberculosis in Cattle in Great Britain.—There is a lack of adequate data concerning the incidence of tuberculosis in cattle in this country. The Cattle Diseases Committee of the Economic Advisory Council reported in 1934 that about 40 per cent. of the total dairy stock in Great Britain might be considered to be infected. The National Veterinary Medical Association in a recent report accepted an incidence of 40 per cent. as a reasonable working figure, stating that local incidence varies from 5 to 90 per cent., and that 0.5 per cent. of cows yield infected milk, though not all the udders concerned are diseased.

A figure of 7-10 per cent. is commonly accepted as the incidence of tubercle

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bacilli in churn milk, and it is considered that practically all samples from large bulked milk containers are infected.

Infection in Cattle due to Tubercle Bacilli of Types other than Bovine.—Infection of pigs with the avian type of tubercle bacillus is common and this type can be passed to cattle from either infected poultry or pigs. The lesions in cattle are of a very restricted nature and do not cause clinical evidence of disease.

The human type of tubercle bacillus can cause a very mild infection in cattle, in this case also without resulting in clinical evidence of disease. Such infection of cattle is considered important in Scandinavian countries.

The significance of infection in cattle with acid-fast bacteria other than the bovine type lies in the fact that the animals become sensitised to tuberculin; this results in an added complication in control measures based upon the removal of reactors to that test. There is another probable cause of sensitisation, hitherto of a rather mysterious nature, a condition in which there are skin lesions containing acid-fast bacteria. The organisms have not been cultivated and all attempts to set up infection with them have failed.

Tuberculosis in Human Beings due to Infection from Cattle.—Roodhouse Gloyne (1944) gave a table modified from one by A. Stanley Griffiths (1937); in it he showed that the percentage of cases in which infection was found to be due to the bovine type of bacillus in *non-pulmonary* tuberculosis in human beings in England and Scotland was respectively:—cervical gland (50; 51.6); lupus (48.7; 69.2); scrofuloderma (36.6 in England); meningeal (24.6; 29.6); bone and joint (19.5; 29.8); genito-urinary (17.4; 31). Also from a table by Griffiths he gave the following percentages of cases in which infection was found to be due to the bovine type of bacillus in *pulmonary* tuberculosis:—*Scotland*:—North-East Rural, 8.5; North-East Urban, 5; Middle and South, 4.6; *England*:—North, 1.6; Middle, 1.4; South, 0.56; *Wales*:—1. Thus the incidence of *pulmonary* tuberculosis in man due to the bovine type was appreciable and greater than was previously realised.

G. S. Wilson (1942) discussed the extent to which human beings acquire tuberculosis from infected milk and concluded that in 1937 somewhere between 1,500 to 2,000 deaths from tuberculosis of bovine origin occurred in England and Wales. The estimate of the Cattle Diseases Committee (1934) was 2,500 deaths annually in Great Britain.

Other Infective Diseases Transmitted by Milk to Human Beings.—G. S. Wilson (1943) emphasised that our knowledge of milk-borne diseases is very incomplete, and that the number of recorded cases of disease represent a gross underestimate of the real incidence.

He considered that 400 to 500 cases of *Brucella abortus* infection occur annually in England and Wales, the great majority of these being due to milk-borne infection. It may be noted that a herd in Staffordshire was found in 1940 to be infected with *Brucella melitensis* and that two other herds had been found to be similarly infected. It is not expected, however, that this organism will gain a foothold in this country.

Scarlet fever and septic sore throat are not infrequently spread by milk, and epidemics are reported from many countries. The causal organism, *Streptococcus pyogenes,* can cause mastitis in the cow and it appears that an infected attendant can pass infection to the cow's udder. Alternatively, the milk can be infected

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directly by a milk handler. As the organism cannot develop in milk under normal trade conditions, direct infection by a milk handler only causes small outbreaks or sporadic cases, but milk from an infected udder can cause serious epidemics.

The organisms of diphtheria, enteric fever, dysentery and cholera can gain access to milk from infected sources. Milk is believed to play an important part in the causation of summer diarrhœa in infants.

Bact. typhi-murium, bact. enteritidis and *bact.-enteritidis var. dublin* cause infection in cattle and in such circumstances the milk may be infected and give rise to epidemics in human beings. Staphylococcal mastitis of the cow leads to the development of the powerful and relatively heat resistant toxin in the milk, with serious effects on those who consume it.

Wilson gave a table showing that, *excluding* tuberculosis, undulant fever and outbreaks due to milk products such as ice cream, cheese and cream buns, 113 outbreaks of milk-borne disease involving 13,679 persons were reported in Great Britain between 1912 and 1937.

Farming and Political Economy

Only an expert is entitled to discuss the subject of farming and political economy in any detail, but it is important to realise the extent to which farming is dependent upon political matters over which the industry has no control. It has been impossible for farmers to foresee what conditions would prevail for any considerable period in the future. There have been periods of unnatural prosperity, with rocketing prices in time of war, and periods of serious depression between the wars. Political considerations have decided both the competition which has to be met in the sales of the farmers' products on account of importation from countries outside the British Isles, and also the conditions under which many of his essential supplies are imported.

In such circumstances, there has been little opportunity for the individual to depart from accepted practice and the conditions for the introduction of desirable changes to prevent disease have not been favourable. It is to be hoped that future governments will give more sympathetic support to agriculture in this country and that, as a result, the industry will have greater stability and prosperity.

The Marketing of Cattle

Systems of marketing cattle in the United Kingdom appear to have evolved which, while providing a certain convenience to the vendor and purchaser, do not give sufficient opportunity for the latter to be reasonably certain that he will obtain a healthy animal. This is rather strange because good health is the first character the buyer expects in his purchase. The buyer relies upon his judgment, which is based chiefly on cursory observation of certain external characters: this is of course useless for the detection of disease, except in the case of some of the more obvious conditions.

With the exception of certain rather special sales of animals which may be regarded so far as from herds of a *de luxe* type, and then only with regard to certain specified diseases, such as tuberculosis contagious abortion, or capacity to breed, no warranty as to health is asked for or offered. A system of selling cattle based to a greater extent upon warranty could it be devised, would be of great value to the industry. In any case it cannot be denied that much effort is wasted under the present system on account of disease which is latent at the time of purchase, and is capable of becoming serious later.

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Self-Contained and "Flying" Herds

The best proposition for the development and maintenance of healthy stock, is the self-contained herd. At the other extreme, the "flying herd" is obviously a bad risk with regard to disease. The modern development of the milk industry has led to the adoption of the "flying herd" system on a very large scale. Commercial dairy herds have to maintain a steady output of milk and so cows in milk yield have to be maintained whatever happens. This tends to result in a vicious circle. New purchases have to be made at relatively short notice to replace cows which cease to yield milk. The system of marketing does not provide a good supply of really healthy calving cows of suitable types. Purchases tend to be made blindly; disease is introduced, or perpetuated, and this makes further purchases necessary. In this way the industry is producing its own problems instead of solving them.

It is known that "flying herds" have a high rate of tuberculosis and that they are the most difficult herds to deal with when eradicating the disease.

The Design of Farm Accommodation

Unhygienic conditions with regard to animal health are very common on farms.

Most farm buildings are old or relatively old, and it is usually difficult or expensive to modify them in such a way as to provide suitable conditions. While there are of course large numbers of modern cowsheds and very up-to-date farms throughout the country, they form only a small proportion of the whole.

Savage (1929) in his book, "The Prevention of Human Tuberculosis of Bovine Origin," was very critical of the hygiene of cowsheds. He said: "Many of the existing cowsheds seem to be constructed and used as if their object was to spread infection as easily as possible." Another quotation from his book is worth recording: "The elaborate evidence as to droplet and cross-infection in dormitories might as well have never been acquired for all the influence it has so far exerted upon cowshed construction." Although this was written sixteen years ago it would be difficult to suggest that it does not apply to farms to-day. In passing it may be noted that observations which were made in hospitals during the war just ended on the spread of infection by bedclothes and floor dust have considerable bearing on conditions in houses used for animals.

When planning farm buildings insufficient attention has usually been given to isolation arrangements.

The fact that animals feed off the ground, on which they defæcate and micturate, is of course a key problem which has to be studied in the development of successful animal husbandry. The great advantages which accrue to husbandry from these very habits have been fully utilised; they are natural habits and become problems only when domestication requires a concentration of animals. The problem is the old one of "overcrowding." As the concentration of animals increases so the threshold to disease falls, unless suitable steps are taken, and the threshold and the conditions which may affect it vary with the disease.

Foodstuffs can be an important source of some infections, and arrangements for their storage and disposal up to the stage when they are put into the manger are often inadequate.

When instructions for controlling disease in a herd have to include such items as the keeping of reactors to an infective disease at one end of the cowshed and

non-reactors at the other end, and the avoidance of storing food near the reactors, little imagination is required to realise that farm hygiene conditions are often bad. The following instructions had to be given a few years ago, and in the same conditions they would have to be repeated now, when some tests on the eradication of bovine brucellosis were carried out for a committee to ascertain how the system on trial would operate in the average commercial herd:—"Both groups [reactors and non-reactors] may be allowed to enter the same shed for the purpose of being milked and stabled, but the reactors must invariably be milked last unless separate attendants are available. If possible, reactors should be accommodated in a separate part of the shed, otherwise they must only be permitted to enter after the healthy animals have been milked and turned out." The instructions were given as an attempt to make the best of bad circumstances, and any hygienist will agree that conditions requiring such makeshift arrangements are unsatisfactory.

Water Supply on Farms

The provision of an adequate and convenient supply of pure water is commonly a great difficulty on farms both inside buildings and at pasture.

Deficiency in the supply of water available on farms causes serious breakdown of essential hygienic standards. Cleansing is impossible and disease factors are given undue opportunities to operate.

A government "white paper" on water supplies was issued in 1943 and if the plans there described become operative a great advance will have been made, but it is doubtful if farms will get all the service that is required.

Drainage in Farm Buildings

Like water supply, the provision of adequate drainage for farm buildings is important and is often insufficient.

The Pasteurisation of Milk

Little need be said on the all-important subject of the pasteurisation of milk beyond assuming that at last there is no serious opposition to its adoption for all milk except that produced hygienically from herds free from at least tuberculosis, brucellosis, mastitis and any other contagious disease, provided that the pasteurisation is properly achieved. Professor G. S. Wilson has given a very full account of the subject in his book, "The Pasteurisation of Milk."

Hitherto there has been some hesitation on the part of the medical profession and on the part of the better educated members of the laity to advocate widespread consumption of liquid milk because of the danger that it might cause disease.

It is clear that, whatever may be done with the assistance of modern science regarding the elimination of disease from cows, and however clean all the arrangements may be from the stage when the cows are groomed prior to milking until the milk reaches the household in its bottle or other suitable container, it is quite impossible to guarantee that it is free from organisms pathogenic for man, unless it is heat treated. If informed circles can say that the risk to human health from raw milk which comes from properly supervised healthy herds is less than the risk from the same milk if pasteurised, the use of such raw milk may be accepted. It is a question of whether any essential element in milk which cannot easily be supplied by other articles of diet is destroyed by pasteurisation. There is no evidence of the existence of such elements, but certain people do believe that they are a factor which demands consideration.

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Wilson has emphasised that if a policy of pasteurisation is to be acceptable, suitable heat treatment of the product is only the final act of a very complex process. The cows which yield the milk should be free from contagious disease and otherwise healthy, the management of the herd, the milking and the handling of the milk must attain a high standard of cleanliness and the pasteurisation plant must be of a suitable type, properly managed and subject to inspection and control.

The Control of Tuberculosis in Cattle

The Control of Tuberculosis by Immunisation.—The extent to which large-scale immunisation can be used as a serviceable measure for the control of tuberculosis is still unknown. BCG vaccine appears to be at least of some value in suitable conditions for preventing serious clinical manifestations of infection. If further tests of this or any other method of immunisation yield evidence that a really useful immunity can be conferred on cattle, such a vaccine could be employed in certain circumstances as part of a control campaign.

The Chemotherapy of Tuberculosis in Cattle.—At a time when specific chemotherapy of bacterial infection is under such intensive study and yielding such spectacular results, it might be suggested that there is justification for delay in commencing eradication by other means, in the hope that some important discovery will revolutionise the position with regard to tuberculosis in cattle.

Whatever may be the chance that a successful curative agent may be found, however, it is certain that proof of its efficiency could be provided only after extensive trial, first on laboratory animals and later on cattle. Its cost would have to be low and it would have to be cheap to use if it were to be of value for the control of such a widespread disease. Whatever the future may hold in this respect, control by the elimination of infection using the powers now available to science, should be the aim at the present time.

Meat Inspection in Relation to the Control of Tuberculosis in Cattle.—In the application of any control plan it would be necessary that important sources of information concerning the extent and incidence of the disease should be studied. The carcases of cattle slaughtered for any purpose provide a master key to the study of the question. It would therefore be specially valuable if there were close collaboration between the departments responsible for meat inspection and for knackeries and other means of disposal of diseased animals. Where necessary the disease could then easily be traced back to the farms of origin, and so provide an invaluable check on the efficiency of the control measures.

It may be added that in the eradication campaign so successfully carried out in the United States of America the Federal Department of Agriculture had this source of information at its command.

Disinfection.—In a tuberculosis eradication campaign disinfection is a most important item. To obtain the best results the use of suitably equipped teams is valuable. In the United States special lorries provided with a petrol driven pump are used. After the routine cleansing and removal of litter the disinfecting team deals systematically with the building, using a suitable disinfectant applied hot and sprayed under pressure.

Instruction of Farmers and their Employees on Matters Concerning Disease Control.—Those responsible for the care of livestock, including the owner, the man in charge of the herd and the cowman, must understand what are the conditions that lead to infection and those which control it; how the germ of the

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disease operates in the body of its host and outside it, and the extent to which an apparently healthy animal can itself develop severe disease, or infect another animal.

In herd management there must be continuity in any system that is practised and this involves the need to ensure that there is no alteration of special routine when one attendant replaces another, such as when duties are changed around while members of the staff are off duty or on holiday. This is often of course, a matter of extreme difficulty and there is therefore, all the more need for an inflexible system in order to avoid breakdown.

In spite of the amount of semi-scientific literature that is produced there is a dearth of suitable books and booklets for the layman explaining the manner in which disease can spread and how those responsible for the animals should do their work in order to eliminate this risk. Something roughly comparable to the course of instruction in the first aid books of the Red Cross and St. John Ambulance Societies is needed, except that it would not deal with first aid. It should be devised specially for persons with an elementary school education and deal with the hygiene of the farm.

At the present time a large proportion of the community is well prepared for such instruction. In service in the Home Guard, Air Raid Precautions Services and in the fighting and other services large numbers have been given specialised instruction on elaborate methods of great importance for the preservation and the taking of life. Such instruction has included explanation of the reasons for taking particular action and the manner in which it should be done. It has included systematic practice of procedures so as to achieve uniformity and avoid the omission of essential stages. Something rather similar could be devised to deal with disease control on the farm.

To be effective such instruction should be given so that it is really convincing and is understood; it should therefore be arranged in a manner which is suitable for the mentality of those concerned.

There is probably a case for teaching some of the matters concerning disease control in rural schools.

Suitable leaflets, handbills and slogans used discriminately would be most useful. Lectures should be given on a wide scale. Suitable instructional films would be of particular value, with arrangements for their exhibition at small gatherings, so that they might be seen repeatedly by most of those concerned.

It is possible that the award of a certificate to those attending a suitable course and passing an examination comparable to those given for human first-aid would stimulate interest.

Control in Other Countries.—I do not propose to review in detail the schemes for tuberculosis control that have been undertaken, but it is necessary to mention the spectacular eradication scheme so recently brought to a successful stage in the United States of America, where within a quarter of a century the incidence of reactors was reduced to less than 0.5 per cent. in every one of the forty-eight States. In Canada great success has also been achieved.

In Norway the disease hardly exists in cattle, and there was little in Finland when war broke out. Other Scandinavian countries have large numbers of herds free from the disease. In most other countries where tuberculosis is a serious problem the results of control measures have been poor or mediocre, but in some

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there are large numbers of herds free from the disease as a result of such measures, though with few exceptions the herds are scattered.

In many European countries there has been a serious over-estimate for many years of the extent to which tuberculosis can be controlled by the detection by clinical methods of cases of the "open" type, and the elimination of the animals from the herds. During the decade prior to the recent war there was a striking change in many countries towards reliance primarily on the tuberculin test. As soon as it was made worth while in various countries for the farmer to rid his herd of the disease, under schemes providing financial assistance to replace reactors, and an increase in the price paid for milk from clean herds, good results began to be reported.

Complete Eradication

It is now quite clear that nothing short of the regular application of the tuberculin test and the elimination of reactors, together with regular veterinary inspection to detect clinically affected animals, will achieve success, and that considerable financial assistance must be given for the replacement of animals that are condemned, together with an enhanced price for milk from herds that are free from the disease. Unless there were a considerable difference between the value of the sales from such herds and those still infected there would not be sufficient inducement for the farmer to co-operate willingly. Furthermore, such subsidy would be the fair way to spread the cost of an eradication campaign over the community which would benefit from it.

In the earlier stages of an eradication policy an "areas plan" must be used. This is probably universally accepted. In the areas first chosen there should be a good proportion of herds free from the disease, or only lightly affected. The types of cattle farming practised would influence the choice of areas, and the localities selected should have natural boundaries. In such areas all cattle would require to come under control. As the disease was eliminated the areas would be enlarged, until ultimately adjacent areas would join, thus making an extensive "clean" area. New areas would gradually be declared until they all joined.

At the same time, it would be advantageous if voluntary eradication were undertaken, with full help from the government, including financial assistance, in parts of the country outside the declared areas. This would tend to increase the supply of "clean" animals for herds under eradication, besides enlarging the number of centres from which the best form of propaganda, actual example, would issue. In this way, too, fresh localities would automatically become ripe for declaration as new *areas*.

For the eradication of tuberculosis from cattle it is axiomatic that the animals should not be submitted to infection from other species of animals or from birds.

Animals in a latent stage of tuberculosis can, of course, often be used with a good deal of success. Indeed, if the fact that infection was present were known, and suitable precautions were taken, there would not be a great deal of objection to utilising a good many animals in this category in certain types of herds until they could be disposed of economically and with safety to the community, provided that adequate precautions were taken to render their products harmless to human beings. Thus reactors free from clinical signs of infection could be moved from herds in the declared areas to herds elsewhere and be utilised in this manner, so long as the herd in which they were placed was known to have a large proportion of reactors.

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One of the chief difficulties in eradicating tuberculosis from the cattle of this country is the amount of money it will cost. While for some proceedings the monetary cost is not to be regarded as the measure of their necessity, the eradication of tuberculosis in cattle cannot be included with reason as one of them, as the heat treatment of animal food products will, in fact, protect the consumer without lowering their nutritive value to an extent that is really objectionable. There is, of course, an ethical aspect with regard to the maintenance of animals with serious infective disease, and also a humanitarian one. The case for eradicating tuberculosis in cattle rest chiefly upon economic considerations. The disease is responsible for great wastage. It considerably shortens the productive life of the animal, diminishes the return obtained for the food consumed, the replacements needed on account of tuberculosis cause additional expense, and labour is devoted to animals that waste it. Tuberculous animal food products have to be condemned as unfit for consumption.

Apart from finance, the difficulty in undertaking eradication in this country arises from two main factors, a shortage of healthy cattle to replace infected animals and a shortage of veterinary surgeons to undertake the work.

There is no short cut for the supply of healthy animals to replace those to be eliminated under an eradication scheme, though much could be done to improve the position in the future. When an efficient eradication policy has been in operation for a certain time, a stage will be reached when so many herds are free from infection that a supply of tuberculosis-free cattle will be available. It is possible that a large number of tuberculosis-free animals could be obtained from the other side of the Atlantic.

The shortage of veterinary surgeons is to be regretted, and it is to be hoped that plans at present under discussion will provide them before long.

There has, perhaps, been some undue caution in the calculations of the number of veterinary surgeons required in the future. It might be suggested that a certain expansiveness in this respect would be justified. Tuberculosis is only one of the diseases to be eradicated from our livestock. Brucella infection will probably have to be similarly dealt with one day. Future research may be expected to provide means for dealing effectively with certain other diseases which are intractable at present, and there again, for a time, additional veterinary staff will be required.

It would be quite safe to make provision for a period of expansion of not less than fifty years, and in these circumstances there need be little hesitation about launching adequate educational schemes for the needs of the present time.

Inquiry Into Means for the Control of Tuberculosis in Cattle

While much has been said about what could be done, there has not been sufficient general investigation of the situation as a whole. Action to overcome one part of a general problem may increase difficulties in other respects.

Tuberculosis is an example of a disease for which a far greater and more concerted effort is required than has hitherto been envisaged. It is a problem involving finance, medical and veterinary science, engineering, public services such as power and water, trade—both national and international—systems of husbandry, economics, industry, and man-power.

There is a need for a detailed integrated report representing all the interests concerned, on the requirements for the eradication of the disease.

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Tuberculosis stands out as the major preventable animal disease in this country which requires to be controlled; it should, however, be realised that its elimination would only be the beginning of a movement to proceed further. Other diseases which now ravage our animals also require energetic attack at the earliest possible moment. One of the greatest contributions of a tuberculosis eradication scheme would be the stimulus and actual aid it would provide for the control of certain other diseases.

Conclusions

In this country, in spite of all that has been done, the quite extensive legislation of the last thirty years, the pioneer work done by the veterinary officers of the Ministry of Agriculture and local government authorities, and by the other scientists and by agriculturists—the present position with regard to tuberculosis control might be described as "the end of the beginning." Even so, a very great deal has been accomplished. The scientific work to provide the essential knowledge has been done. A great wall of opposition has been broken down. The leaders of agricultural interests are clamouring for action. The veterinary service is organised, but at the present time it is numerically insufficient to undertake even the next stage which the Government is anxious to put into effect. A considerable increase in the number of veterinary graduates is urgently required.

All milk, except that from herds free from tuberculosis and the other important infective diseases, should be pasteurised, and there appears to be little objection to the pasteurisation of all milk.

An intensive educational programme, covering the requirements of both the workers in the cattle industry and the consumers of their products, should be undertaken. A suitable manual is required for the instruction of animal attendants.

Much could probably be done within the cattle industry to assist this control work. The marketing of cattle is not well organised with regard to the opportunity for the purchaser to select healthy animals. In existing circumstances it is difficult to control disease in the "flying herd."

Agriculture requires a long period of steady prosperity. Farm accommodation is often inadequate. Water supplies must be considerably improved.

An "area" system for the eradication of tuberculosis should be started as soon as possible.

An inquiry into means of controlling tuberculosis and a detailed report embodying all the interests concerned in the problem are required.

The methods used in the eradication of tuberculosis will have a great influence in due course on action to be taken for the control of other infective diseases of farm animals.

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MALIGNANT CATARRHAL FEVER

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MALIGNANT catarrhal fever, also known as malignant head catarrh, is frequently and erroneously diagnosed, clinically, as peracute hæmorrhagic septicæmia. Any discussion of this condition must, unfortunately, be pigeon-holed in the group of disease entities in which we must confess that little is known and that, logically, much remains to be proven. The recent experimental work of Daubney and Hudson has added considerable enlightenment to the confusion regarding the ætiology in conjunction with its variegated clinical manifestations and pathologic processes. Control of the disease has, and continues to be, seriously handicapped by the lack of any conclusive evidence regarding its reservoir and mode of transmission.

The causative agent is a virus, which, according to its geographical distribution, appears to vary in virulence and in its ability to cause the acute and chronic forms of the disease. Under natural conditions, there is no evidence to the effect that the virus is transmitted either by direct or indirect contact. Daubney and Hudson report one case of direct transmission. It has been suggested that a vector is the possible means of transmission. However, it has been rather conclusively proven that lice and ticks do not transmit the virus. Although it may be observed any season of the year, its higher incidence during the winter and early spring months in a temperate zone would tend to rule out a vector as the means of transmission.

That cattle contract the disease from close association with sheep is not generally accepted. We do not know. Situated in the largest sheep feeding district in the world, there is undeniable clinical evidence that the incidence of the disease is much higher on farms and ranches where cattle and sheep raising and feeding are associated. Let us not jump at conclusions until accurate, clinical statistical data, combined with exhaustive research, have proved or disproved this observation.

The period of incubation in experimental transmission is from two to four weeks and longer. Under normal infection, the incubation period can be estimated as long as several months. Feeder cattle seldom become affected before sixty days after admission into the feed lots. When it once appears on a premise it is likely to reappear in succeeding years. Again, one wonders if the virus, once introduced on a premise, is capable of living over from year to year.

Generally, we must accept the fact that most cattle either develop a subclinical form of the disease or that they are naturally immune. The usual picture is that 1 or 2, and rarely 3, in the average feed lot of 120 head will become affected. One large feeder of 5,000 cattle has from 9 to 15 cases annually. Another, who feeds 800 head, has 4 to 8 cases annually. Our records tend to demonstrate that 1 per cent., and not over 2 per cent., of animals succumb to the disease in apparently infected premises. There are exceptions in which it may be higher.

In our clinical experience we have recognised only the peracute type of the disease. The clinical manifestations are ushered in with dramatic suddenness and are of an explosive character. The history usually reveals that the affected animal appeared normal the night before, only to be found critically ill the next

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morning. Or that the animal was observed to be normal at the morning feeding, and found in the afternoon suffering from some fulminating condition. Undisturbed, they usually stand by themselves, presenting a picture of extreme dejection, exhibiting a most pronounced and severe dyspnœa. The first impression is that there is some acute pulmonary involvement, because of the respiratory embarrassment. If observed early in the course of the disease, when approached some degree of excitation is manifested. The head will be thrown upward and backward suddenly in a stary or startled expression, and the animal either assumes an aggressive attitude or will run and collide with feed troughs or the fence. This reaction is due, in part, to the impaired vision. Detailed examination will reveal an extremely high temperature, 106 to 108 degrees. A temperature of 107 degrees is most common. The entire head often presents generalised œdema. Œdema may, or may not, be present in the submaxillary space.

Severe lacrimation, producing a moist condition of the hair of the face, is present. The eyelids may be œdematous. In the initial stages, photophobia is usually observed. There is partial cloudiness to complete opacity of the cornea, producing partial or complete blindness. Pulsation of the minute scleral vessels is characteristic. The condition of the muzzle will vary from cyanosis to crusting and necrosis, depending upon the state of the disease. There is a mucopurulent discharge that is characteristically yellow and becomes heavier and more fœtid with progress of the case. The nasal discharge is frequently streaked with blood and flakes of necrotic tissue. The nasal roar is characteristic, due to the narrowing of the nasal passages from the hæmorrhagic, œdematous mucosa, plus the accumulated mucopurulent exudate.

On percussion, extreme tenderness is manifested over the paranasal sinuses and cranial cavity. The horns are hot to the touch.

Hyperæsthesia of the skin is present early in the course of the disease and concomitant with excitation, and motor irritative phenomena are displayed by muscular fibrillations and spasms. Auscultations reveal an acute laryngitis and tracheitis. Regardless of the acute dyspnœa, pneumonia is seldom present. Pulmonary emphysema is observed usually in twenty-four to seventy-two hours, and occasionally there is escape of air into the subcutaneous tissues along the back.

In some instances, constipation is observed early, but in most cases there is an enteritis, which results in a diarrhœa.

There is complete inappetence and little desire for water. Dehydration is rapid and pronounced. The animal loses weight rapidly. Many die in twenty-four hours, others will live for three or four days—even a week or ten days—animals in the best flesh are most likely to succumb early.

Following the first five or six days of the disease, the horns may be cast by simply grasping them to steady the head, or the hoof may be shed if the animal stumbles.

Anoxæmia is acute, as exhibited by the black venous blood on venipuncture. In this district, mortality is at least 90 per cent. Recovery is slow, and relapses are frequent in three or four weeks at the time when recovery seems hopeful.

The diagnosis of this condition is most commonly confused with shipping fever or so-called hæmorrhagic septicæmia. Differential diagnosis is not difficult. Shipping fever is usually associated with shipment or within the first two weeks after reception in the feed lots. It usually affects the majority or all of the herd.

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Temperatures will vary from 103.5 to 105.5 degrees. There will be depression without excitation, lacrimation without initial opacity of the cornea, acute inflammation of the upper air passages, frequently complicated with congestion of the lungs and pneumonia. The nasal discharge is not tenacious or ropy. On the other hand, malignant catarrhal fever is usually limited to one or two animals in the herd. It appears at any time during the feeding season, but is seldom observed at the time of shipping. It strikes an animal of apparent excellent condition and resistance. The high temperature of 107 degrees is of signal importance in malignant catarrhal fever.

The changes in the head and the eye, and the typical nasal discharge with fœtid breath, are outstanding. The extreme respiratory embarrassment without pneumonia, but with pulmonary emphysema, is quite diagnostic. The brevity of its course and high mortality must be taken into consideration.

Autopsy Findings

There is severe hæmorrhagic, œdematous and necrotic nasal mucosa. This is particularly true of the turbinate area. The paranasal sinuses are red and œdematous, and contain a mucopurulent exudate. There is an acute hæmorrhagic pharyngitis, laryngitis, and tracheitis, with severe œdema.

The lungs exhibit an interstitial emphysema, and occasionally an early bronchial pneumonia is observed after several days' standing.

The anterior chamber of the eye is filled with a turbid exudate.

The lymph glands are hæmorrhagic and œdematous.

Gastrointestinal tracts vary from a mild to an acute hæmorrhagic gastritis, enteritis and colitis, and in some instances show ulceration.

The spleen is slightly swollen and the liver is enlarged.

Kidneys are typically pulpy with multiple hæmorrhagic foci in the cortex. Cystitis is common.

The brain shows congestion and œdema of the leptomeninges.

Perivascular œdema is more pronounced in the cerebellum than in the cerebrum.

Treatment

It is useless to talk about " specific " or " scientific " treatment of this condition. Treatment has been entirely symptomatic. Regardless of the fact that the disease does not spread by contact, the affected animal, or animals, should be segregated. Based on experience, they should be confined to a dark boxstall that is warm, yet well ventilated, and with plenty of bedding. This removes the chances of injury from other animals or from self-inflicted injuries that may result during the stage of excitation.

Medicinal treatment has little or no apparent effect on the course of the disease, and is most discouraging and unsatisfactory both to the veterinarian and the client.

On the basis of respected tradition, we have used every therapeutic agent which we thought might be of any value. Ceremoniously, we have administered most agents that are tolerated intravenously, including dyes, iodides, formalin, nonspecific proteins, arsenicals, blood transfusions, etc. The results have been very unsatisfactory.

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With the introduction of the sulphonamides, they were used with the idea of overcoming the secondary invaders, but they have been equally disappointing. More recently, penicillin has been administered every three hours in enormous dosage without beneficial results.

To date, the most hopeful regimen to follow is rest by isolation in comfortable quarters, good nursing, overcoming dehydration by the frequent administration of large amounts of a 5 per cent. dextrose solution. All means and measures should be exercised to conserve resistance.

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USE OF D.D.T. AGAINST SHEEP TICKS, IXODES RICINUS L.

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Introduction

THE sheep tick, *Ixodes ricinus L.*, which occurs over large areas of Great Britain, appears to feed on any warm-blooded animal (Macleod, 1932), but is of major importance only as a parasite of cattle and sheep. It is the vector of bovine piroplasmosis, louping ill, and tick-borne fever, and is thought to be associated with the occurrence of the disease called tick pyæmia. Ticks appear to cause little irritation, but loss of blood sustained by host animals must be considerable, and, where infestation is heavy, this may cause unthriftiness. Hill sheep farmers suffer large annual losses directly (tick-borne diseases) and indirectly (unthriftiness) due to the tick. Mail (1942) states that treatment of pastures with an acaricide is too extensive to be practicable, and in Great Britain the habits of the tick and the character of the countryside prohibit this method of attack (Macleod, 1941). Unless conditions permit radical alteration of the habitat of the tick (e.g., by the ploughing up of old grassland), the tick must be killed while it is on the host animal. On hill farms, treatment of the skin and fleece of sheep is the most logical approach to the problem.

The insecticide D.D.T. has been shown by Burtt (1945) to be effective in killing ticks under laboratory conditions, and in view of the fact that it retains its toxicity over long periods of time (Buxton, 1945) it offers hope of protecting sheep from ticks and reducing the tick population of infested areas. To investigate the possibilities of D.D.T. as a practical acaricide, a series of small-scale trials were conducted at Weybridge, followed by trials on a larger scale on a hill farm in Cumberland.

Methods

Although spraying may eventually supersede dipping as a method of rendering sheep acaricidal, dipping was chosen as being the more common procedure. The selective methods of skin, hair, and fleece treatment which were used for experimental purposes, and which normally are not encountered on farms, are dealt with during description of results. The dips used were made up as stock emulsions, miscible oils, and dispersible powders for dilution in the field, and their compositions are given in Table IV. Reference will be made to this table through-

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out the text. For the preparation of the "mayonnaise" type of emulsions, the oil phase and the water phase were separately made up; the former by adding to the solvent all the constituents shown above the double line (Table IV) and warming to dissolve; the latter by adding the constituents below the double line (Table IV) to water, with the exception of those formulæ containing casein, in which cases the protein material was brought into solution by first warming in dilute aqueous alkali.

Using a jet type of emulsifying machine (B.P. 407153/1934, Gas Light and Coke Co.), the water phase was circulated at approximately 40° C., and the oil phase gradually added to the circulating liquid. This process was continued until the required degree of dispersion, as indicated by microscopic examination of a diluted sample, was achieved.

In the group of self-emulsifying miscible oils, the anionic type M36 was prepared by mixing the oil-soluble constituents, with the exception of the cresol, and warming to dissolve. Next, the caustic alkali was added as a 50 per cent. aqueous solution to form the soap, followed by Teepol X and finally m-cresol to "solubilise" the components and create a clear one-phase system. The cationic type, M37, was obtained by dissolving Fixanol C in the warm D.D.T.-solvent naptha solution, and a small quantity of glacial acetic acid added to clarify the liquid. In a similar manner, the neutral oil M38 was made by dissolving D.DT.. and Turkey red oil in solvent naptha and adding m-cresol to clarify the cloudy solution.

In the beginning little was known about the desirable properties of dips, but all field trials were accompanied by chemical and microscopical examination of samples, and considerable developments have occurred. In general, the mayonnaise type of concentrate was used, and these emulsions have been kept as simple as possible. The main object has been to place D.D.T. on the skin and fleece of sheep with as few complicating factors as possible, and the dips are not to be regarded as finished commercial products.

The experimental dipping bath held 120 gallons of dip, in which each sheep was held for 30 seconds, during which time its head was immersed at least four times. After dipping, the sheep passed into draining pens, from which excess dip ran back into the bath. Samples of the bath were taken at intervals, and samples of fleece after the sheep had dried. Groups of 20-150 Herdwick and Swaledale sheep were used, and in all field trials the same commercial arsenic wool-grease cresylic acid dip was used as a control. The sheep, after dipping, were run on to tick-infested fell and periodically collected to pens, where attached female ticks were counted. At this point it is necessary to define exactly the method of counting and to give the evidence on which it is based. Of 24,388 attached female ticks counted on 1,248 undipped sheep, 47 per cent. were attached on the ears, 18 per cent. on the face, 22 per cent. on the axillæ, and 13 per cent. on the groins. A few ticks were present in the fleece proper, but observation showed that these find great difficulty in escaping after engorging, as they tend to become entangled in the wool fibres and so die. In this paper the counts refer to females attached on the ears, face, and axillæ; other females, larvæ and nymphs are not included. This method was used by Macleod (1939). The term "tick count," in every case, refers to the arithmetic mean of the group counted.

Assessment of the efficacy of any anti-tick treatment can be made in several

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ways. First, there are two aspects of any control measure; the repellant effect, and the direct toxic effect, i.e., chemical treatment of the sheep may prevent attachment of the tick, or, while allowing attachment, may kill the tick during its feeding period. In any case, the important factor in assessment must be a consideration of the number of viable ticks which are *shed by the sheep;* i.e., the number which can complete their life cycle. Second, for the purpose of comparison undipped sheep may not be reliable controls, since even the commercial arsenical dips used under normal conditions provide some small measure of protection for about 30 days. For these reasons care must be taken in planning methods of assessment of tick control achieved by dipping.

Results

As a toxicity test, a group of sheep (4 Cheviot hoggs, 1 Swaledale ewe, and 1 Herdwick hogg) was dipped in D.D.T. emulsion at bath concentrations of about 0.5 per cent. D.D.T. thirteen times during a 41-day period. Throughout the period of dipping and during the 60 days following, no sheep showed any sign of illness. Concentrations of 6 to 7 per cent. D.D.T. were obtained in fleece samples from these sheep.

To discover whether D.D.T. *per os* is likely to be toxic to sheep in doses which might be swallowed during dipping, 4 ewes were dosed by mouth with the following amounts of D.D.T. dissolved in arachis oil:—

Ewes Nos. 1 *and* 2: 3.4 gm. each over a period of 32 days, and a further 15.2 gm. each during the following 29 days. Maximum dosage: 0.9 gm. daily.

Ewes Nos. 3 *and* 4: 9.1 gm. each over a period of 32 days, and a further 21.1 gm. each during the following 29 days. Maximum dosage: 1.8 gm. daily.

After receiving 17.6 gm. D.D.T. during the first 37 days, sheep No. 3 developed inco-ordination of gait, and, when startled, behaved in a manner reminiscent of a case of louping ill. The dose of D.D.T. was dropped from 1.8 gm. to 1.4 gm. per day, and this ewe made an uneventful and rapid recovery. None of the other ewes showed any symptoms of illness throughout the period of D.D.T. administration or during the six months following cessation of dosing. Woodward *et al.* (1944) showed that D.D.T. is absorbed well when fed *per os* in arachis oil, and absorption from this vehicle would probably be at least as good as absorption from the emulsions used in sheep dips. A sheep dipped in D.D.T. at bath concentration of 0.5 per cent. would need to swallow 11 ounces of dip in order to get the 1.8 gm. D.D.T. which was found to be a safe dose even when frequently repeated.

Facilities for intensive watching of individual ticks on sheep have been limited, but of 100 female ticks which attached on 12 sheep which had been dipped in D.D.T., 20 detached one day, 58 two days, 8 three days, 10 four days, 2 five days, and 2 six days after attaching. The usual time taken for a female tick to engorge is in the region of 7days (Macleod, 1932). Of the 100 ticks examined, 61 were observed to have died, while others disappeared between successive observations. It is reasonable to suppose that the absentees may be counted as dead, since: (a) they may have been detached following death, or have died after detaching, and (b) complete engorgement of the female tick is necessary for reproduction to follow its normal course (Campbell, 1945).

Thus, of 100 ticks examined, only 4 were at all likely to produce even small

numbers of larvæ, and of these 4, 2 appeared to be moribund on the day previous to their absence being noted, while the other 2 were still far from being engorged. The period covered by this intensive watching was the 18 days immediately following dipping. In the light of this finding, care must be taken in assessing the results obtained with D.D.T. on the basis of tick counts, since many ticks which are counted may never manage to lay viable eggs. The appendix note by K. L. Blaxter deals with this aspect.

TABLE I.

Dip	Bath conc. of D.D.T. %	+Tick counts of dipped sheep expressed as number of ticks per 100 present on control *dipped* sheep. ††Days after dipping 10	20	30	40	50	+Tick counts of dipped sheep expressed as number of ticks per 100 present on *undipped* control sheep. ††Days after dipping 10	20	30	40	50	Protection afforded by Dip.
M10	0.10	9800	—	—	—	—	—	—	—	—	—	None
M10	0.30	25	18	39	—	—	—	—	—	—	—	Good
M11	0.30	125	21	40	—	—	—	—	—	—	—	Good
M11	0.50	33	20	23	58	41	—	—	—	—	—	Excellent
M18	0.50	93	84	—	—	—	—	—	—	—	—	Poor
M22	0.50	80	59	114	—	66	20	36	29	—	60	Poor
M22	0.50	129	74	118	—	73	32	45	30	—	66	Poor
M22	0.75	113	70	104	—	66	28	42	27	—	60	Poor
M22	1.00	78	57	146	—	85	13	34	37	—	77	Poor
M22	0.50	166	8	22	30	—	7	4	11	29	—	Excellent
M34	0.50	8	3	34	43	62	1	3	16	43	36	Excellent
M35	*0.50	14	33	34	60	54	1	25	16	35	32	Excellent
M35	0.75	8	20	83	50	38	1	15	39	30	23	Excellent
M36	0.50	43	43	68	60	23	3	33	32	35	14	Excellent
M37	†0.50	71	25	32	170	46	5	2	15	100	27	Fair
M37	0.20	71	43	38	60	92	5	33	18	35	55	Good
M38	0.50	129	135	62	—	—	10	104	29	—	—	Poor
M42	*0.50	65	61	—	—	—	20	75	—	—	—	Poor
M42	*0.25	103	71	—	—	—	32	87	—	—	—	Poor
M42	0.75	83	60	—	—	—	26	73	65	—	—	Poor
M42	0.10	134	77	—	—	—	42	96	—	—	—	Poor
M42	2.00	38	36	64	66	—	8	35	66	75	—	Good
M53	0.50	15	40	—	—	—	5	48	45	—	—	Good
M54	*0.50	24	38	—	—	—	7	47	57	—	—	Good
M54	*0.50	41	29	57	50	—	9	26	39	58	—	Good
M54	*0.30	8	55	45	73	—	2	49	47	85	—	Good
M54	0.50	44	49	76	43	—	9	44	52	50	—	Good

+Calculated $\frac{100 \times \text{No. on dipped sheep}}{\text{No. on controls}}$ using all counts made. Thus low values indicate good protection.

††In many cases circumstances prevented counting on dates stated, but made as nearly as possible to these dates. †Used as foot and head.

*Face, ears, axillæ and groins treated with acetic acid before dipping.

In Table I, results of field trials are seen to have been very variable. For example, on one occasion when M22 was used at a bath concentration of 0.5 per cent. D.D.T., the resulting protection from ticks was excellent. In four other trials, using M22 at a concentration as high as 1.0 per cent., results obtained were only comparable to the control dip.

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Since the greatest numbers of ticks are found on the ears, face, axillæ, and groins of sheep, and, in any case, counts in this paper include only those ticks found on head and axillæ, it seems logical to assume that high concentrations of D.D.T. on the long fleece are not necessary, and that poor results obtained in the field trials may be explained by low depositions of D.D.T. on the hairless and short-haired parts. Arising from a communication from Dr. W. Moore, Marischal College, Aberdeen, on the importance of pH of the fleece, the behaviour of natural fleece in emulsions of various types was studied. If a natural fleece fibre is placed in an anionic emulsion, microscopic examination shows that the oil globules are distributed at random over the field (Fig. 1). If, on the other hand, the fibre is placed in a cationic emulsion, the globules are attracted to the fibre (Fig. 2). This can also be demonstrated by deposition of oil soluble dyes on fleece from emulsions of varying charge. It was further observed that a reversal of this phenomenon could be brought about by conditioning the fleece in N/2 acetic acid, followed by thorough washing in water. The conditioned

TABLE II.

Dip	Bath conc. D.D.T. %	Particle size in bath	Fleece conc. D.D.T. 1st sheep through bath %	Fleece conc. D.D.T. Last sheep through bath %	Type of Emulsion	Treatment of sheep before dipping	Remarks	Protection against ticks
M10	0.10	2— 6p	—	—	Anionic	None	Bath conc. fell during dipping	None
M10	0.30	2— 6p	1.80	0.60	Anionic	None	Bath conc. fell during dipping	Good
M11	0.30	1— 5p	1.80	—	Neutral	None	Bath conc. fell during dipping	Good
M11	0.50	1— 5p	3.40	0.90	Neutral	None	Bath conc. fell during dipping	Excellent
M18	0.50	1— 2p	—	—	Neutral	None	Bath conc. fell during dipping	Poor
M22	0.50	1— 2p	—	—	Anionic	None		Excellent
M22	0.50	1— 2p	—	—	Anionic	None		Excellent
M22	0.75	1— 2p	—	—	Anionic	None		Poor
M22	1.00	1— 2p	—	—	Anionic	None		Poor
M22	0.50	1— 2p	—	—	Anionic	None		Poor
M34	0.50	1—15p	2.50	3.90	Anionic	None		Excellent
M35	0.50	1— 2p	—	0.90	Anionic	Acetic Acid		Poor
M35	0.75	1— 2p	—	2.90	Anionic	None		Excellent
M36	0.50	5—10p	2.10	1.30	Anionic	None		Excellent
M37	0.50	1—20p	—	—	Cationic	None	Foot and head bath	Fair
M37	0.20	1—20p	5.60	—	Cationic	None		Good
M38	0.50	2— 5p	1.70	—	Neutral	None		Poor
M42	0.50	1— 2p	*0.10		Anionic	Acetic Acid		Poor
M42	0.25	1— 2p	*0.60		Anionic	Acetic Acid		Poor
M42	0.75	1— 2p	*0.40		Anionic	None		Poor
M42	0.10	1— 2p	—		Anionic	Acetic Acid		Poor
M42	2.00	1— 2p	*2.00		Anionic	None		Good
M53	0.50	5—10p	—		Neutral	None	Dispersible powder	Good
M54	0.50	2— 6p	*1.10		Anionic	Acetic Acid		Good
M54	0.50	5—10p	*3.70		Anionic	Acetic Acid		Good
M54	0.30	5—10p	—		Anionic	Acetic Acid		Good
M54	0.50	5—10p	*3.20		Anionic	None		Good

*Sample taken from middle sheep through bath.

Table II. shows the physical data which are available concerning the dips used in field trials tabulated in Table I.

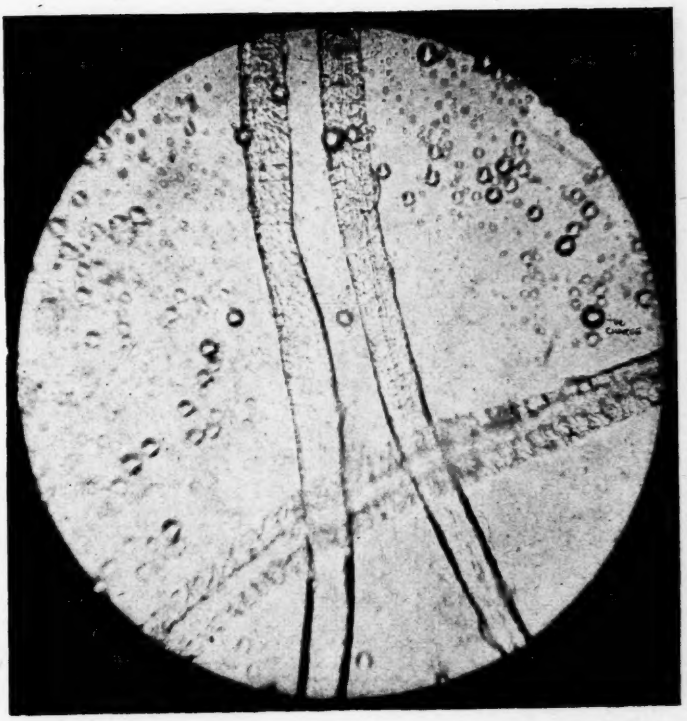

FIG. 1

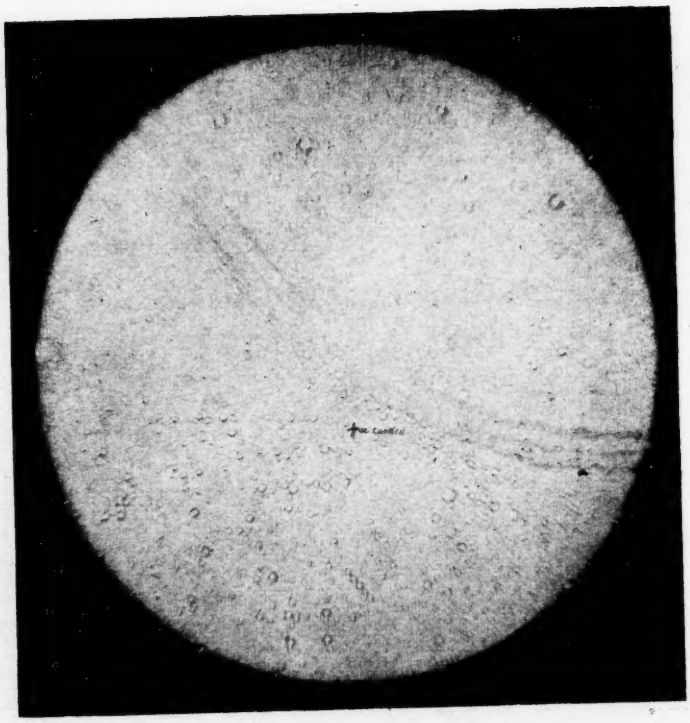

FIG. 2

fibre attracts globules from an anionic emulsion. An application for a patent covering this process has been filed by the Department of Scientific and Industrial Research (21341/45). Two possible methods of placing a high deposit of D.D.T. on selected parts of the fleece were thus available.

(1) Treatment of the selected parts with a cationic dip.

(2) Treatment of the selected parts with acetic acid, followed by an anionic dip. In a small-scale trial, the use of a cationic emulsion produced large deposits of D.D.T. on the fleece, and the bath was rapidly depleted.

In Table I, dips marked with an asterisk were used on sheep which had previously been either swabbed over the head, axillæ, and groins with acetic acid at a concentration of 1 pint glacial acetic acid to 5 gallons water, or walked

TABLE III.

Protection	Particle size	Type	Bath conc. %	Fleece conc. First %	Fleece conc. Last %	Pre-treatment	Dip
None	2— 6p	Anionic	0.10	—	—	None	M10
Poor	1— 2p	Neutral	0.50	—	—	None	M18
Poor	1— 2p	Anionic	0.50	—	—	None	M22
Poor	1— 2p	Anionic	0.50	—	—	None	M22
Poor	1— 2p	Anionic	0.75	—	—	None	M22
Poor	1— 2p	Anionic	1.00	—	—	None	M22
Poor	2— 5p	Neutral	0.50	1.70	—	None	M38
Poor	1— 2p	Anionic	0.10	0.10		Acetic Acid	M42
Poor	1— 2p	Anionic	0.25	0.40		Acetic Acid	M42
Poor	1— 2p	Anionic	0.50	0.40		Acetic Acid	M42
Poor	1— 2p	Anionic	0.75	—	—	None	M42
Fair	1—20p	Cationic	0.50	—	—	None	M37*
Good	2— 6p	Anionic	0.30	1.80	0.60	None	M10
Good	1— 5p	Neutral	0.30	1.80	—	None	M11
Good	1—20p	Cationic	0.20	5.60	—	None	M37
Good	1— 2p	Anionic	2.00	2.00		None	M42
Good	5—10p	Neutral	0.50	—	—	None	M53
Good	2— 6p	Anionic	0.50	1.10		Acetic Acid	M54
Good	5—10p	Anionic	0.50	3.70		Acetic Acid	M54
Good	5—10p	Anionic	0.50	—	—	Acetic Acid	M54
Good	5—10p	Anionic	0.50	3.20		None	M54
Good	5—10p	Anionic	0.50	2.90		Acetic Acid	M54
Excellent	1— 5p	Neutral	0.50	3.40	0.90	None	M11
Excellent	1— 2p	Anionic	0.50	—	—	None	M22
Excellent	1—15p	Anionic	0.50	2.50	3.90	None	M34
Excellent	1— 2p	Anionic	0.50	—	0.90	Acetic Acid	M35
Excellent	1— 2p	Anionic	0.75	—	2.90	None	M35
Excellent	5—10p	Anionic	0.50	2.10	1.30	None	M36

*Foot and Head bath.

through a shallow bath (deep enough to wet axillæ and groins) of this mixture, the head being ducked under once during passage through the bath. Dip No. M37 was cationic, and at a bath concentration of 0.2 per cent. D.D.T. gave good protection. In one trial (M37 at 0.5 per cent. D.D.T.), instead of being dipped sheep were walked through a bath of dip just deep enough to wet axillæ and groins, and each sheep had its head ducked under at least four times during the 30 seconds of its stay in the bath.

In Table III an effort has been made to correlate the physical properties of dips with degree of protection from ticks. No very obvious conclusions emerge, but from the few figures available it is suggested that a high deposition of D.D.T. in the fleece was associated with good protection from ticks in field trials. It is considered unlikely, however, that D.D.T. in the fleece *per se* is responsible for the high degree of protection; a more probable conclusion is that the high deposi-

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TABLE IV.
Composition of Dips.

Dip No.		M10	M11	M18	M22	M34	M35	Miscible oils M36	Miscible oils M37	Miscible oils M38	M42	M54
PERCENTAGE COMPOSITION OF STOCK EMULSION BY WEIGHT	D.D.T.*	21.10	24.70	21.90	12.50	12.50	12.50	26.30	31.60	22.70	15.00	12.50
	BENZENE		29.60		18.80							
	SOLVENT† NAPTHA						18.75	52.63	63.20	45.40	34.10	
	CREOSOTE	31.70		32.00		19.00						20.00
	PARAFFIN (KEROSENE)	7.90		8.20								
	TAR ACIDS											7.50
	m-CRESOL							5.29		4.59		
	OLEIC ACID	8.90			5.30	5.00	5.30	11.84			6.30	5.00
	CAUSTIC SODA	1.30		0.10	0.80	0.70	0.70	1.40			0.75	0.62
	PERMINAL		11.40	4.40								
	FIXANOL C								4.74			
	TEEPOL X							1.14			1.80	1.50
	CASEIN	2.60		1.70	1.60	1.60	1.56					
	WATER	26.40	34.30	31.70	61.00	61.20	61.19	1.40			42.05	52.88
	GLACIAL ACETIC ACID								0.46			
	TURKEY RED OIL						27.30					

*During 1945 the D.D.T. was the commercial article supplied by Geigy with an average pp' content of 81%.

†Distillative range of Solvent Naphtha employed and recommended was 90 per cent. by weight boiling 140 degrees-220 degrees C.

tion in the fleece is merely indicative of high depositions on the skin and short hairs. This point is being investigated.

Summary and Conclusions

(1) Twelve different emulsions containing D.D.T. were used as anti-tick sheep dips at both concentrations of 0.1-2.0 per cent. In 15 out of a total of 27 field trials, the protection achieved by D.D.T. was arbitrarily classed as "excellent" or "good" when compared with protection given by a commercial anti-tick dip; in the remaining 12 trials protection was classed as "fair," "poor," or "nil."

(2) While D.D.T. may prove to be a valuable aid to tick control, results obtained have been too variable to allow formulation of specific recommendations.

(3) Physical and chemical data obtained from examination of bath and fleece samples have not given a clear indication of the cause of irregular results, but high deposition of D.D.T. in the fleece appears to be associated with good protection from infestation by ticks.

(4) Day to day watching of individual attached ticks on D.D.T. dipped sheep showed that the majority of these ticks were unable to engorge. Counts given in the text refer to every female attached on the areas counted, and since many of these probably failed to complete engorgement (thus breaking the life cycle), mere consideration of the counts probably does not do justice to the D.D.T. dips. This may account for some of the apparent discrepancies in the results, which in future will be avoided by more intensive watching of the fate of ticks after attachment.

(5) It is considered that the use of D.D.T. as an anti-tick sheep dip cannot be recommended on a large scale until more information regarding dipping procedure and preparation of emulsions becomes available.

Acknowledgments

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APPENDIX

Statistical Note on Tick Control Experiments

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THE paper of Mitchell and Heath, above, describes trials of acaricidal dips containing D.D.T., and it is therefore of interest to consider how the efficacy of the described technique, and of other dipping and spraying procedures, can

best be assessed. Perhaps the best definition of effective tick control is "any method of sheep treatment which prevents the ticks completing their life cycle." Thus ticks could theoretically be controlled by the use of repellants preventing attachment of the tick, or by acaricides which kill the tick once it has attached. These two basic methods of control are considered separately in the first instance, for a number of commercial dips are stated to have a repellant effect (Heath, 1945), and the ultimate population of ticks on the treated sheep is generally a result of both methods of control being in operation.

The tick population of the individual is, of course, not static. Ticks continually attach, and after a period of time (6-8 days, depending on the stage of development), having engorged with blood, fall off. It appears from Mitchell and Heath's observations that ticks killed *in situ* on the sheep by an acaricide also fall off when they have been killed. To measure a repellant effect and to separate it from a direct caricidal effect, it is necessary to count the total number of ticks, alive or dead, which are shed by treated and untreated sheep in a convenient period of time. Simple counts of the tick populations of the sheep themselves do not provide this information, for such a count is also a partial measure of the direct acaricidal effect. The estimation of the statistical significance of this repellant effect can be made by a "t test" (Student, 1908) of the number of ticks shed by the two groups of sheep. It may, however, be necessary to normalise the frequency of distribution of the counts, using a square root, or log $(x + 1)$, or other transformation (Gaddum, 1946) before applying the "t test." A consideration of the work of Milne (1943) on the errors of tick counts indicates, however, that such a transformation would only be necessary in the assessment of the exact significance of a very large repellant effect. A more simple method would be to estimate the significance of the single statistic "R"

$$\text{"R"} = 100 \left\{ \begin{array}{l} \text{Total ticks} \\ \text{shed by all} \\ \text{control sheep.} \end{array} - \begin{array}{l} \text{Total ticks} \\ \text{shed by all} \\ \text{treated sheep.} \end{array} \right\} \div \begin{array}{l} \text{Total ticks} \\ \text{shed by all} \\ \text{control sheep,} \end{array}$$

for where large numbers of ticks are counted the error of the count can be taken as $\sqrt{n}$ and the error of "R" arrived at by simple calculation.

The separate direct assessment of the acaricidal effect can be made in a similar way by counting the number of viable and non-viable ticks shed by treated and untreated sheep. This, too, can be expressed in a single statistic, "A,"

$$\text{"A"} = 100 \left\{ \frac{\text{Total} - \text{Dead.}}{\text{Total.}} \right\} \text{Total on control sheep.} - \left\{ \frac{\text{Total} - \text{Dead.}}{\text{Total.}} \right\} \text{Total on treated sheep.}$$

and its significance best assessed by a calculation of X^2 for the 2 x 2 contingency table below :—

	Viable Ticks.	Non-viable Ticks.
Control sheep	a	b
Treated sheep	c	d

$$\text{when } X^2 = \frac{(ad - bc)^2}{(a+b)\ (c+d)\ (b+d)}$$

These two basic methods of assessment of tick control express in single statistics "R" and "A" what control has been effected by the two methods; their

errors are easily calculated and their significance tested. They are not suitable for field scale trials, as counting shed ticks would only be possible on a laboratory scale, and the only information available here is the count of ticks attached to control and treated sheep. This information is mixed information and extremely difficult to interpret, even though "t tests" on the counts show a significant reduction in numbers. An example of the interpretational difficulties reveals this in a striking way. Heath (1945) found 200 ticks on control sheep and 160 ticks on treated sheep, and the difference was just statistically significant ($P = 0.05$). Some possible conclusions on the efficacy of control are as follows:

(1) 20 per cent. of the ticks were repelled by the dip.

(2) 20 per cent. of the ticks were killed by immediate contact with the dip.

(3) 100 per cent. of the ticks were killed by the dip, but there was a time lag of 80 per cent. x 8 days = 6.4 days between attachment (i.e., contact with D.D.T.) and death.

(4) 40 per cent. of the ticks were killed by the dip if there was a time lag of 4 days between contact with D.D.T. and death.

(5) 10 per cent. of the ticks were repelled by the dip and 20 per cent. were killed after an interval of 4 days.

Other hypotheses can also be considered, giving estimates varying from 20-30-100 per cent. control of the ticks, and this shows that the problem of assessing tick control from sheep counts is not purely a statistical one of measuring error, but is rather one of estimation of a number of basic parameters.

It is of interest, however, to devise a method of assessment of control which makes the minimum assumptions and yet gives an estimate of control which has some reliability. The effect of D.D.T. on the tick is a slow effect, and an attempt to measure the mean survival time of the tick on the treated sheep can therefore be made. If the number of ticks on treated sheep is x, on the control sheep y, and z is the number of days the tick is normally attached, then $\frac{xz}{y}$ is the mean survival time of ticks on treated ewes. The error of this is much higher relatively than the difference between the two counts x and y, for z has an appreciable variance (Heath, 1945). The significance of control will then be $z\frac{(1-x)}{y}$ representing the difference between mean survival time and the average normal length of attachment. The error of this was calculated to be:—

$$\sigma z\,\frac{(1-x)}{y} = z\,\frac{(1-x)}{y}\sqrt{\frac{\frac{\sigma_z^2}{z^2} + \left(\frac{x^2}{y}\right)\frac{2\sigma_t^2}{}\left(\frac{1}{x^2}+\frac{1}{y^2}\right)}{\frac{(1-x)^2}{y}}}$$

where σ_z^2 = the variance of Z.

σ_t^2 = the variance of the tick counts x and y.

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This error expression, however, assumes that the frequency distribution of survival time of ticks on treated sheep is of the same shape as that of the normal length of the sojourn of ticks on normal sheep. This is unlikely, and it is therefore probable that $\sigma^2 \frac{zx}{y}$ actually measured will be greater than when the same variance is calculated from the discrete errors σz, σx and σy, and also probable that it will vary with $\frac{zx.}{y}$ Thus even this attempt to devise a method of assessment of the degree of control and its error involves a fundamental assumption, and can only be used if that assumption can be substantiated.

In conclusion, therefore, to interpret tick populations on D.D.T. treated and normal sheep, problems of estimation of additional parameters are involved, any method must make assumptions concerning the mode of action of the D.D.T., and no rigid conclusion on the degree of control can be formulated without the estimation of these factors. The only unequivocal estimates of control in the absence of such information is the enumeration of viable and non-viable ticks shed by the two groups of sheep.

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Correspondence

FOOD FOR THOUGHT

Sir,

As a Veterinarian who has had the good fortune to travel extensively, I am convinced that we have not been, and are not being, used professionally as we should be, for the nation's benefit. I am referring especially to the supply of meat as food.

For some years I have been practising in Australia, and have no hesitation in saying that the expert examination of meat here will compare favourably with any part of the world. Further, that in spite of rationing by the authorities supplies have been more than ample, in fact large quantities of mutton and lamb could have been shipped home except for some reason known to the authorities in England.

This valuable food, although used by fastidious meat eaters here, was not considered good enough for the starving inhabitants on the other side of the world.

This so-called detriment, a minor trouble designated Caseous lympha-

denitis, is easily detected and removed on examination, and we in Australia, the Land of Plenty, are gladly consuming this mutton and lamb every day. So would the veterinary profession and educated people at home and on the Continent, if allowed to.

What is the veterinary profession doing in the matter? Surely meat as a food comes in their province—if not, why are they trained specially as meat experts?

Another illustration of depriving the people of good meat as food can be given in the capital city of Melbourne. Melbourne has a population of over one million people with an excellent water supply and sewage disposal system. The sewage is carried by pipes and concrete channels to a farm of about 23,000 acres situated some distance (30 miles) from Melbourne. It is disposed on the farm mainly by gravity irrigation into grazing pastures of about 10,000 acres specially graded and prepared for such irrigation. The result is probably the best grazing area for that size in the world. A few years ago beef measles was detected in some of the animals and then vested interests got busy. A ban was imposed which prevented the cattle being used for food; the primest of animals, well bred and in wonderful condition, were simply boiled down for tallow in thousands.

Later, during the shortage of beef owing to the extra demand for the Army and restricted supplies for civilians caused by drought, the Commonwealth Government lifted the ban and allowed this meat to be used for Australian consumption but not for export. As a matter of fact thousands of these cattle were sold through the Melbourne market and proved of great value, as beef supplies were short for some time. Among the consumers, to my personal knowledge, were not only qualified meat inspectors but many of the leaders in the medical profession who were not only acquainted with the facts but had visited and inspected the much maligned farm. These leaders in the community not only sought this meat for themselves but also gave it to their families.

Surely, again, when one has seen the meat of low grade that even in the good old times was used in England and the Continent and the old, decrepit and diseased horses that found their way not to racing dogs but to human workers—a qualified man cannot help but wonder, "What's wrong with the world and with our profession?"

Only a few months back a carcase weighing over 800 lb. of the very best quality beef was condemned because one (1) live cyst had been found in the heart. A very thorough search could not detect another in any part of the carcase and the search was most thorough. Treatment by low temperatures would, of course, make such meat safe; so also would canning, but this meat is too high in quality and contains too much fat for canning—an inferior grade is preferred.

XUM

The following concrete statistical returns should be worthy of publication:—

STATISTICAL RETURN.

Number of Cattle sold since lifting of ban (April, 1942) on Board's Cattle to June 30, 1945.

Financial Year.	Number Sold.	Net Market Sales.
1941/42	280	4,362
1942/43	4,655	65,733
1943/44	6,549	128,332
1944/45	6,389	126,200
	17,873	£324,627

Number of Sheep sold during the past five financial years to June 30, 1945.

Financial Year.	Number Sold.	Net Market Sales (including wool)
1940/41	72,078	90,360
1941/42	66,535	90,216
1942/43	6,137	10,586
1943/44	1,515	3,070
1944/45	6,813	13,071
	153,078	£207,303

Since the ban on sale of Board's Cattle was lifted, the Board has sold to July 31, 1945:—

Sales of Cattle to June 30, 1945 ...	17,873	324,627
Add sales July, 1945	950	19,341
Total ...	18,823	£343,968

Total value of Sheep and Cattle sold as per above return:—

Sheep	207,303
Cattle	343,968
	£551,271

Return of cattle rejected for Cysticercus Bovis as per Abattoirs' Certificates, since ban on sale of Board's Cattle was lifted (April, 1942) to July 18, 1945, inclusive:—

	Total Number Condemned	Total Number Sold		Percentage of Rejections
Purchased bullocks	251	9,434	=	2.66
Farm bred steers	22	5,262	=	0.42
„ „ cows	14	3,900	=	0.36
Total	287	18,596	=	1.55

Number of Calves Branded for Five Years to June 30, 1945.

1940/41	1,738
1941/42	2,110
1942/43	2,018
1943/44	2,108
1944/45	3,609
Total	11,583

These figures are sufficiently illuminating to produce the evidence as to why pressure was brought to put the ban on this wonderful food supply. Further, marvellous as that production was on practically 10,000 irrigated acres, had encouragement been given far greater quantities of beef could have been produced as a war effort. However, the breeding scheme which is now resulting in an annual increase of over 3,000 calves is no small attainment, especially as all of these are outstanding stock, the sires being selected Shorthorn, Hereford or Aberdeen Angus bulls, in some instances costing over £1,000.

The farm as a farm and the stock as regards quality, condition and health are a combination without equal anywhere in the world, and when the public are educated the demand for the meat will be such as to prevent any legislation in future interfering with a national food contribution of this description.

On the face of these facts, am I justified in asking, "Is the veterinary profession fulfilling its duties in the councils of the nation?"

"IMPERIALIST."

DEAR SIR,

IODINE PHARMACOPŒIA

We should be grateful if you would permit us to mention in your columns a project we have in hand, and to invite the co-operation of your readers.

Medical men, veterinary surgeons, research workers and others, here and abroad, are turning to the Iodine Educational Bureau in increasing numbers for up-to-date information about the availability of products which contain iodine or iodine compounds. To meet this demand we are compiling an Iodine Pharmacopœia.

Would your readers whose products contain iodine or any of its compounds be good enough to send us details of their products for inclusion in the Pharmacopœia? We wish to make it as comprehensive as possible and world-wide in scope.

XUM

We should be happy to supply forms upon which the kind of information desired may be entered. No charge will be made for the Pharmacopœia.

Yours faithfully,

for Iodine Educational Bureau,

ARTHUR LAWSON.

Stone House,
Bishopsgate,
London, E.C.2.

News

GOLD COAST TUBERCULOSIS SURVEY

THE National Association for the Prevention of Tuberculosis, which has already conducted medico-social surveys on tuberculosis in various parts of the British Commonwealth, is now undertaking, in co-operation with the Government of the Gold Coast, a survey of the problem in this colony. A Research Fellow, who will be a specialist doctor and have a technical assistant, is to be appointed to conduct a twelve months medico-social survey, and the National Association for the Prevention of Tuberculosis will publish in due course a report of his findings.

Publishers' Notices

Copy of advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 1st of the month, if proof is required.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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